Microprocessor and Computer Architecture

UE21CS251B

4th Semester, Academic Year 2022-23

Date:

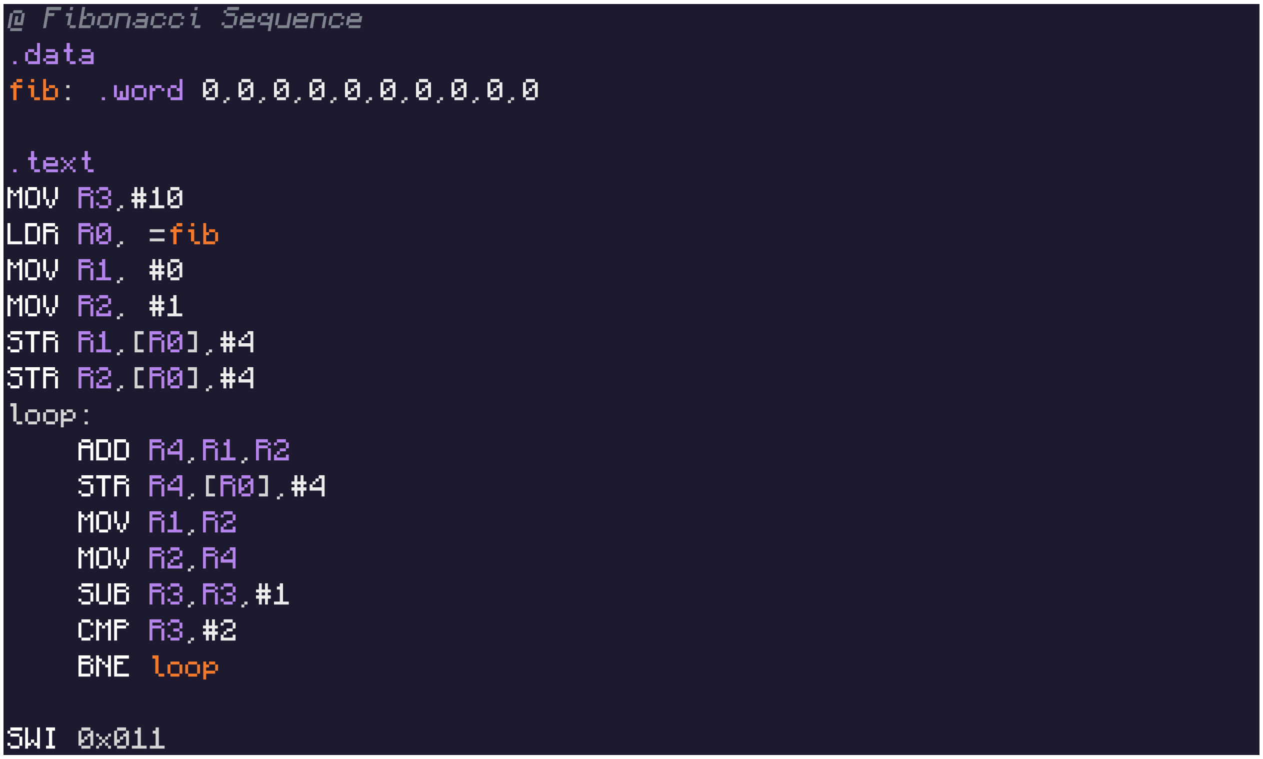
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____1__

Title of the Program

Generate Fibonacci Series and store them in an array.

I.ARM Assembly Code:

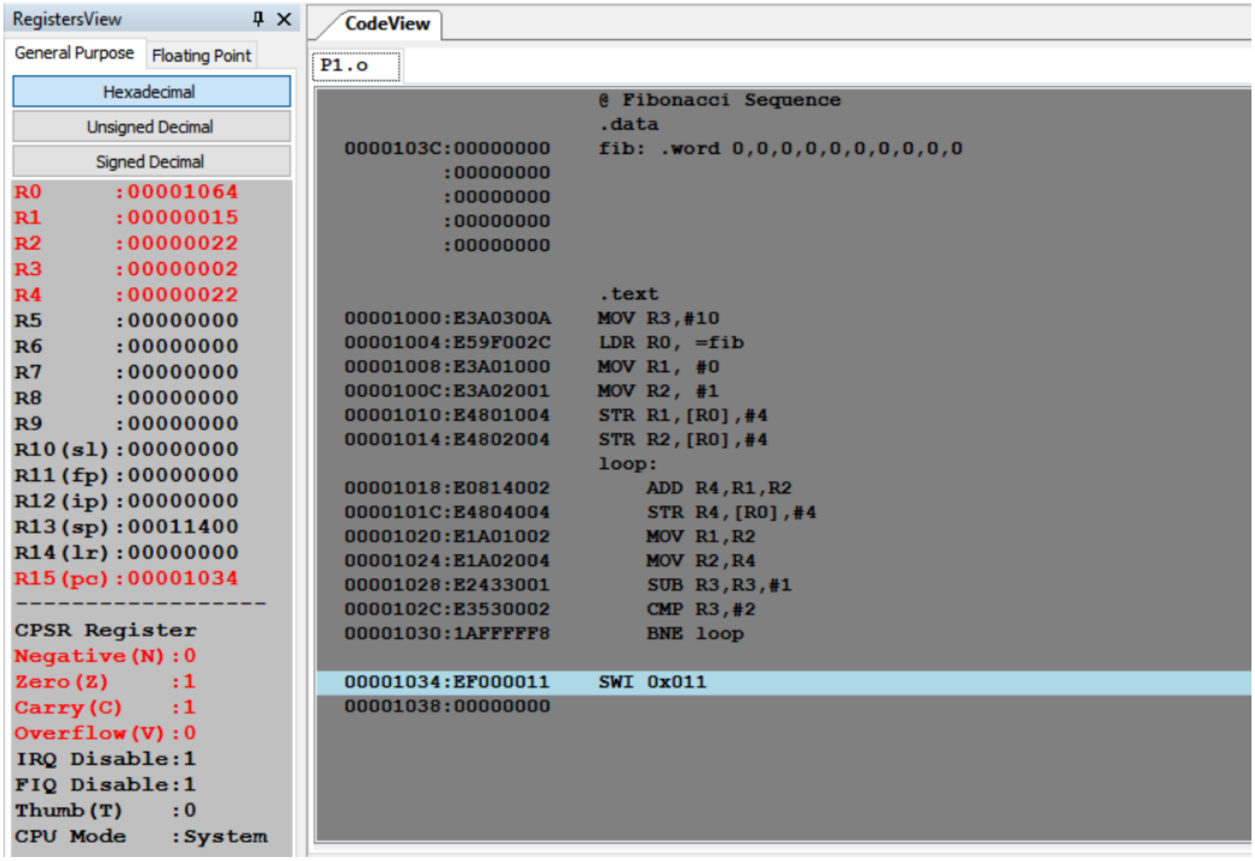


```
@ Fibonacci Sequence
.data
fib: .word 0,0,0,0,0,0,0,0,0,0

.text
MOV R3,#10
LDR R0, =fib
MOV R1, #0
MOV R2, #1
STR R1,[R0],#4
STR R2,[R0],#4
loop:
    ADD R4,R1,R2
    STR R4,[R0],#4
    MOV R1,R2
    MOV R2,R4
    SUB R3,R3,#1
    CMP R3,#2
    BNE loop

SWI 0x011
```

II. Output Screen Shots (One)



```
R0       :00001064
R1       :00000015
R2       :00000022
R3       :00000002
R4       :00000022
R5       :00000000
R6       :00000000
R7       :00000000
R8       :00000000
R9       :00000000
R10(sl)  :00000000
R11(fp)  :00000000
R12(ip)  :00000000
R13(sp)  :00011400
R14(lr)  :00000000
R15(pc)  :00001034
------------------
CPSR Register
Negative(N):0
Zero(Z)     :1
Carry(C)    :1
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
```

```
                        @ Fibonacci Sequence
                        .data
0000103C:00000000       fib: .word 0,0,0,0,0,0,0,0,0,0
         :00000000
         :00000000
         :00000000
         :00000000

                        .text
00001000:E3A0300A       MOV R3,#10
00001004:E59F002C       LDR R0, =fib
00001008:E3A01000       MOV R1, #0
0000100C:E3A02001       MOV R2, #1
00001010:E4801004       STR R1,[R0],#4
00001014:E4802004       STR R2,[R0],#4
                        loop:
00001018:E0814002           ADD R4,R1,R2
0000101C:E4804004           STR R4,[R0],#4
00001020:E1A01002           MOV R1,R2
00001024:E1A02004           MOV R2,R4
00001028:E2433001           SUB R3,R3,#1
0000102C:E3530002           CMP R3,#2
00001030:1AFFFFF8           BNE loop

00001034:EF000011       SWI 0x011
00001038:00000000
```

Microprocessor and Computer Architecture

UE21CS251B

4th Semester, Academic Year 2022-23

Date:

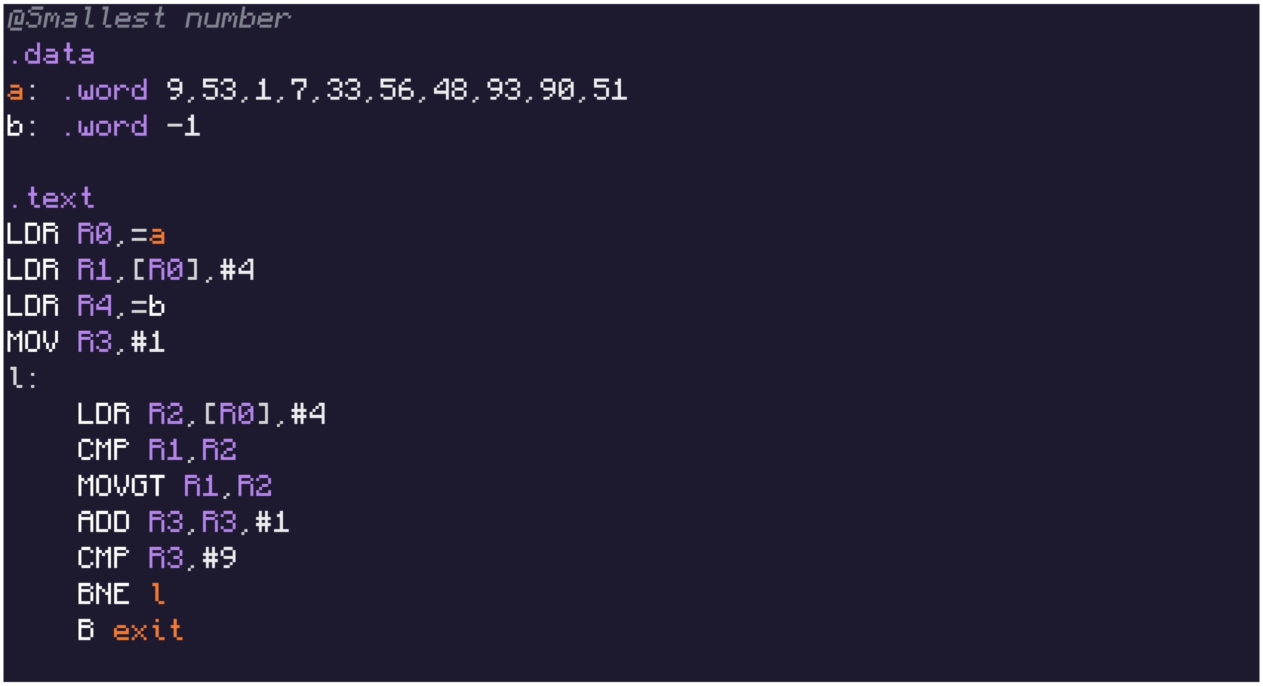
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____2___

Title of the Program

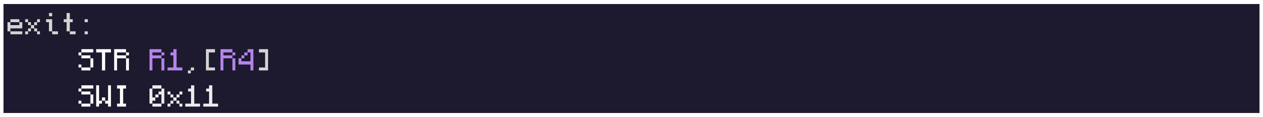
Write an ALP to find smallest number in an array of n 32-bit numbers

I.ARM Assembly Code:



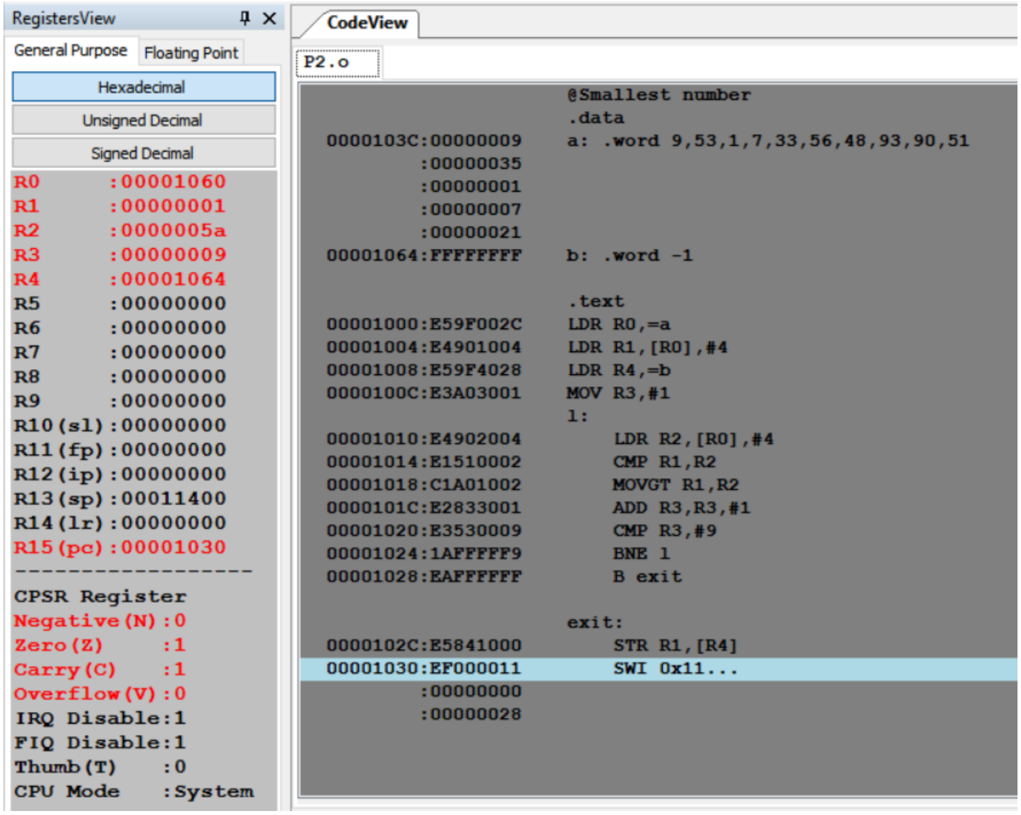
```
@Smallest number
.data
a:  .word 9,53,1,7,33,56,48,93,90,51
b:  .word -1

.text
LDR R0,=a
LDR R1,[R0],#4
LDR R4,=b
MOV R3,#1
l:
    LDR R2,[R0],#4
    CMP R1,R2
    MOVGT R1,R2
    ADD R3,R3,#1
    CMP R3,#9
    BNE l
    B exit
```



```
exit:
    STR R1,[R4]
    SWI 0x11
```

II. Output Screen Shots (One):



```
R0        :00001060
R1        :00000001
R2        :0000005a
R3        :00000009
R4        :00001064
R5        :00000000
R6        :00000000
R7        :00000000
R8        :00000000
R9        :00000000
R10(sl):00000000
R11(fp):00000000
R12(ip):00000000
R13(sp):00011400
R14(lr):00000000
R15(pc):00001030
------------------
CPSR Register
Negative(N):0
Zero(Z)     :1
Carry(C)    :1
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
```

```
                            @Smallest number
                            .data
  0000103C:00000009         a: .word 9,53,1,7,33,56,48,93,90,51
          :00000035
          :00000001
          :00000007
          :00000021
  00001064:FFFFFFFF         b: .word -1

                            .text
  00001000:E59F002C         LDR R0,=a
  00001004:E4901004         LDR R1,[R0],#4
  00001008:E59F4028         LDR R4,=b
  0000100C:E3A03001         MOV R3,#1
                            l:
  00001010:E4902004             LDR R2,[R0],#4
  00001014:E1510002             CMP R1,R2
  00001018:C1A01002             MOVGT R1,R2
  0000101C:E2833001             ADD R3,R3,#1
  00001020:E3530009             CMP R3,#9
  00001024:1AFFFFF9             BNE l
  00001028:EAFFFFFF             B exit

                            exit:
  0000102C:E5841000             STR R1,[R4]
  00001030:EF000011             SWI 0x11...
          :00000000
          :00000028
```

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4th Semester, Academic Year 2022-23

Date:

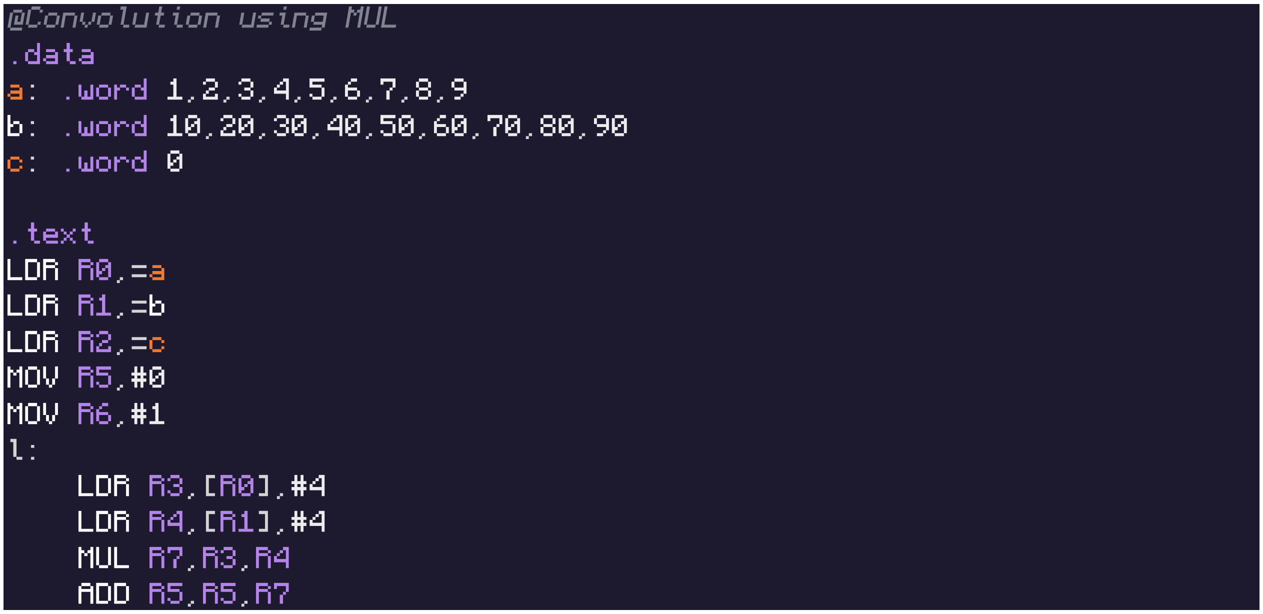
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____3__

Title of the Program

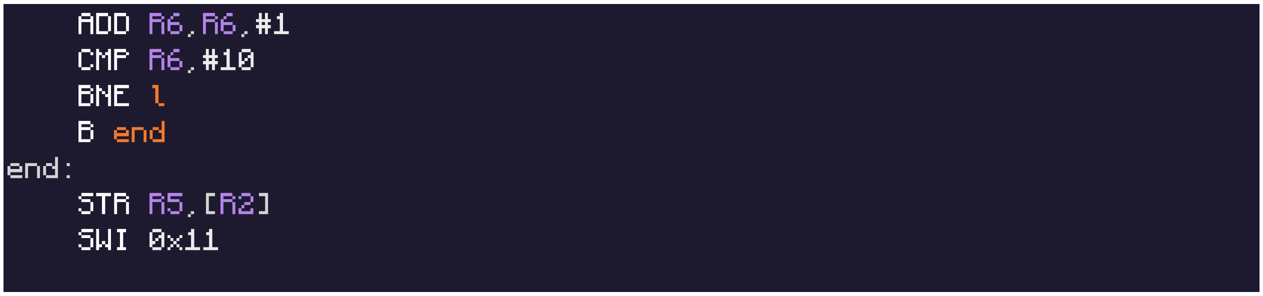
To perform Convolution using MUL instruction (Addition of multiplication of respective numbers of loc A and loc B)

I.ARM Assembly Code:



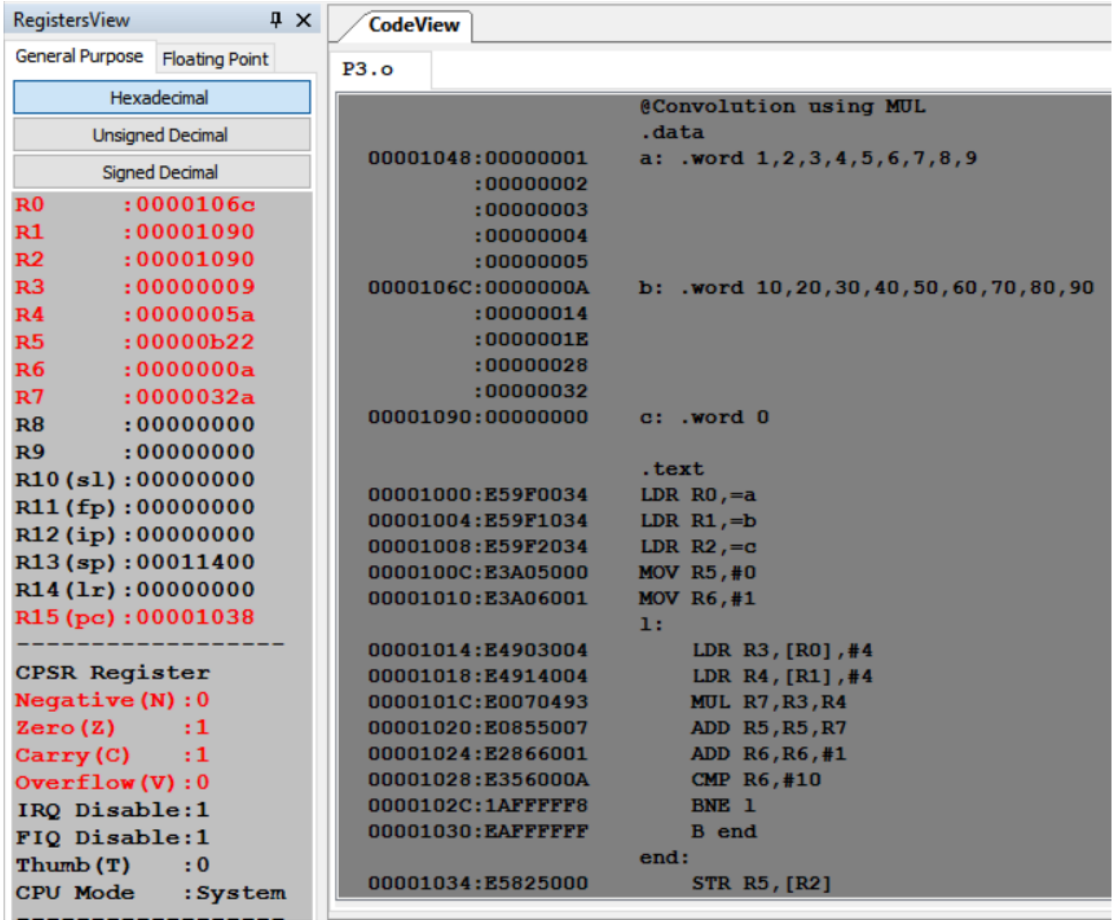
```
@Convolution using MUL
.data
a:  .word 1,2,3,4,5,6,7,8,9
b:  .word 10,20,30,40,50,60,70,80,90
c:  .word 0

.text
LDR R0,=a
LDR R1,=b
LDR R2,=c
MOV R5,#0
MOV R6,#1
l:
    LDR R3,[R0],#4
    LDR R4,[R1],#4
    MUL R7,R3,R4
    ADD R5,R5,R7
```



```
    ADD R6,R6,#1
    CMP R6,#10
    BNE l
    B end
end:
    STR R5,[R2]
    SWI 0x11
```

II. Output Screen Shot (One):



```
R0       :0000106c
R1       :00001090
R2       :00001090
R3       :00000009
R4       :0000005a
R5       :00000b22
R6       :0000000a
R7       :0000032a
R8       :00000000
R9       :00000000
R10(sl)  :00000000
R11(fp)  :00000000
R12(ip)  :00000000
R13(sp)  :00011400
R14(lr)  :00000000
R15(pc)  :00001038
------------------
CPSR Register
Negative(N):0
Zero(Z)    :1
Carry(C)   :1
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)   :0
CPU Mode   :System
------------------
```

```
                           @Convolution using MUL
                           .data
00001048:00000001          a: .word 1,2,3,4,5,6,7,8,9
        :00000002
        :00000003
        :00000004
        :00000005
0000106C:0000000A          b: .word 10,20,30,40,50,60,70,80,90
        :00000014
        :0000001E
        :00000028
        :00000032
00001090:00000000          c: .word 0

                           .text
00001000:E59F0034          LDR R0,=a
00001004:E59F1034          LDR R1,=b
00001008:E59F2034          LDR R2,=c
0000100C:E3A05000          MOV R5,#0
00001010:E3A06001          MOV R6,#1
                           l:
00001014:E4903004              LDR R3,[R0],#4
00001018:E4914004              LDR R4,[R1],#4
0000101C:E0070493              MUL R7,R3,R4
00001020:E0855007              ADD R5,R5,R7
00001024:E2866001              ADD R6,R6,#1
00001028:E356000A              CMP R6,#10
0000102C:1AFFFFF8              BNE l
00001030:EAFFFFFF              B end
                           end:
00001034:E5825000              STR R5,[R2]
```

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UE21CS251B

4th Semester, Academic Year 2022-23

Date:

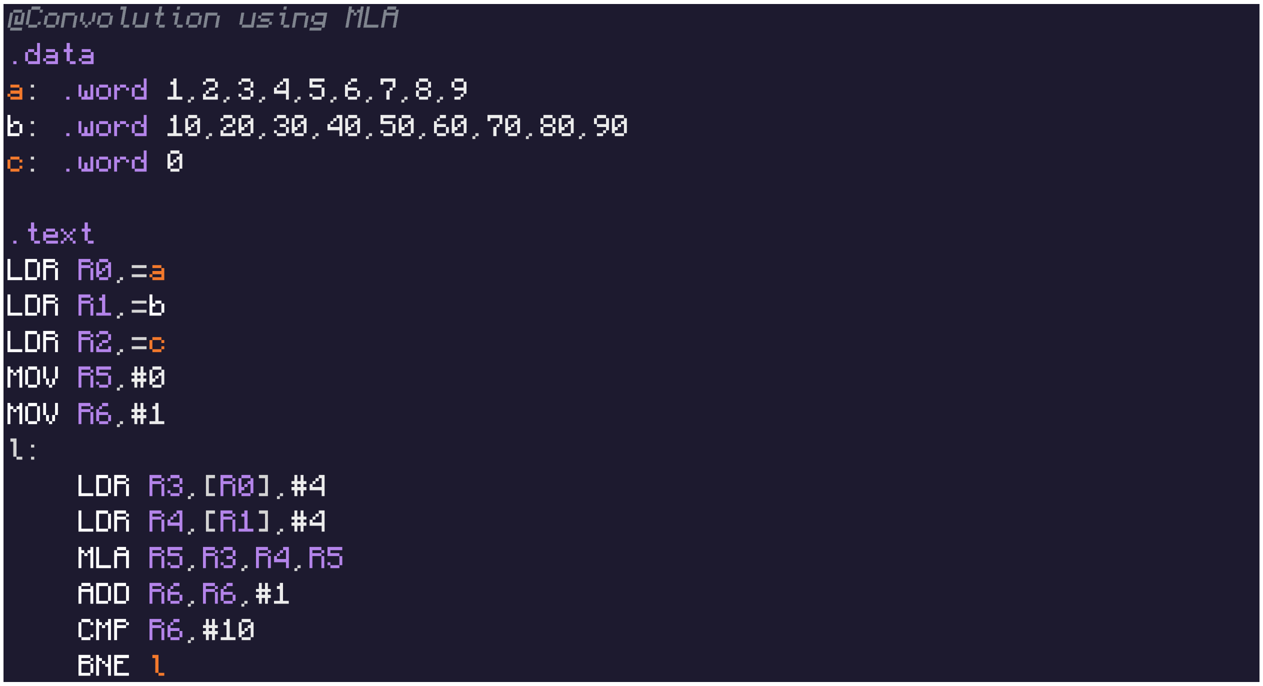
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____4___

Title of the Program

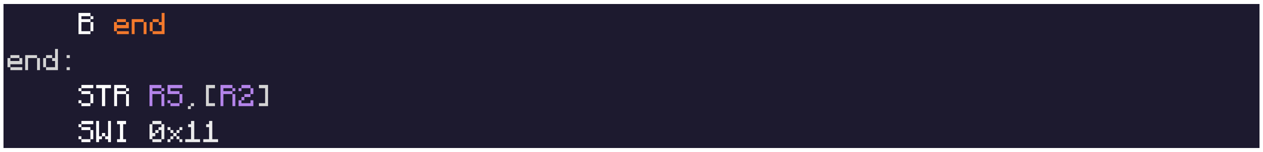
To perform Convolution using MLA instruction (Addition of multiplication of respective numbers of loc A and loc B).

I.ARM Assembly Code:



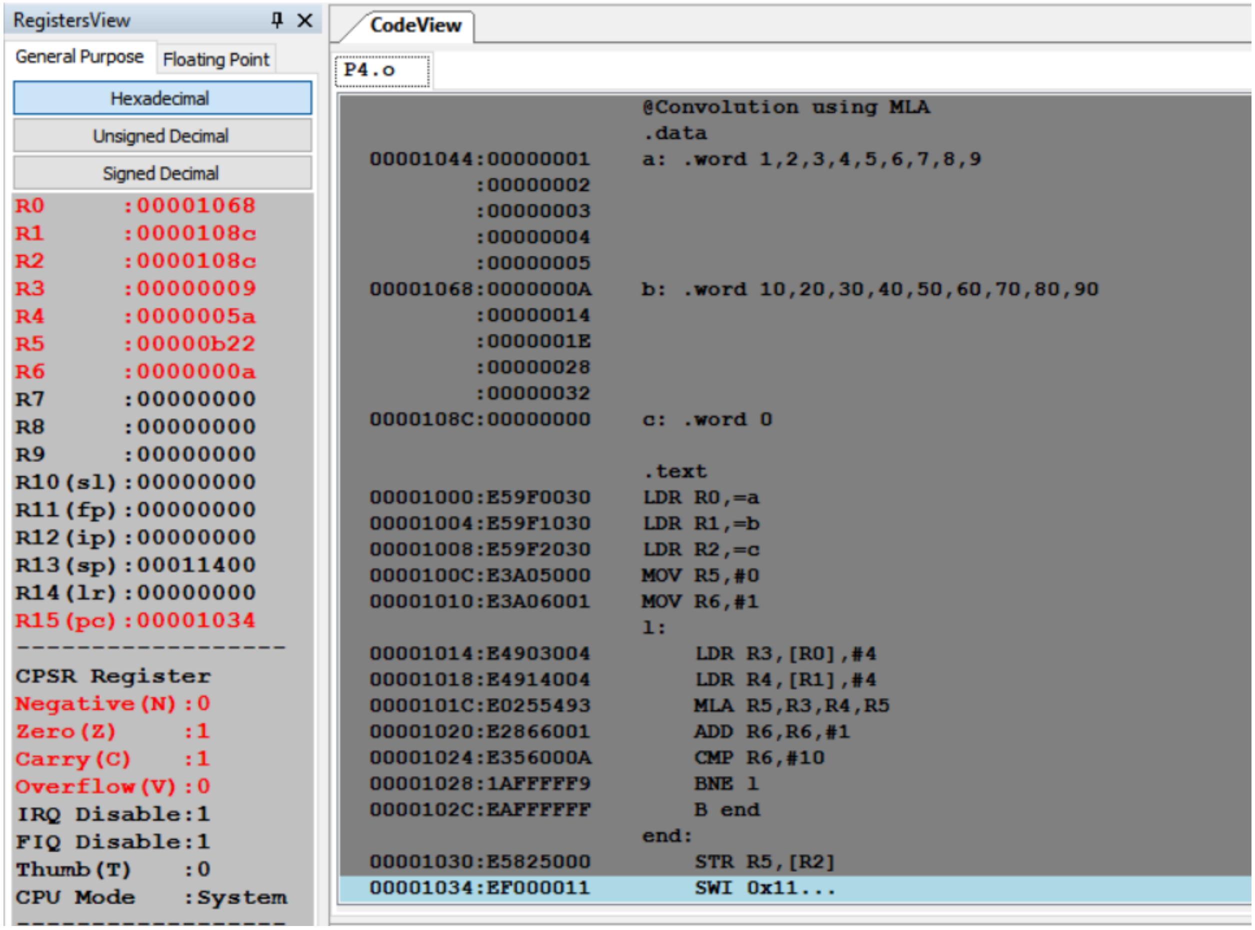
```
@Convolution using MLA
.data
a:  .word 1,2,3,4,5,6,7,8,9
b:  .word 10,20,30,40,50,60,70,80,90
c:  .word 0

.text
LDR R0,=a
LDR R1,=b
LDR R2,=c
MOV R5,#0
MOV R6,#1
l:
    LDR R3,[R0],#4
    LDR R4,[R1],#4
    MLA R5,R3,R4,R5
    ADD R6,R6,#1
    CMP R6,#10
    BNE l
```



```
    B end
end:
    STR R5,[R2]
    SWI 0x11
```

II. Output Screen Shot (One):



```
R0       :00001068
R1       :0000108c
R2       :0000108c
R3       :00000009
R4       :0000005a
R5       :00000b22
R6       :0000000a
R7       :00000000
R8       :00000000
R9       :00000000
R10(sl):00000000
R11(fp):00000000
R12(ip):00000000
R13(sp):00011400
R14(lr):00000000
R15(pc):00001034
------------------
CPSR Register
Negative(N):0
Zero(Z)     :1
Carry(C)    :1
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
------------------
```

```
                        @Convolution using MLA
                        .data
00001044:00000001       a: .word 1,2,3,4,5,6,7,8,9
        :00000002
        :00000003
        :00000004
        :00000005
00001068:0000000A       b: .word 10,20,30,40,50,60,70,80,90
        :00000014
        :0000001E
        :00000028
        :00000032
0000108C:00000000       c: .word 0

                        .text
00001000:E59F0030       LDR R0,=a
00001004:E59F1030       LDR R1,=b
00001008:E59F2030       LDR R2,=c
0000100C:E3A05000       MOV R5,#0
00001010:E3A06001       MOV R6,#1
                        l:
00001014:E4903004           LDR R3,[R0],#4
00001018:E4914004           LDR R4,[R1],#4
0000101C:E0255493           MLA R5,R3,R4,R5
00001020:E2866001           ADD R6,R6,#1
00001024:E356000A           CMP R6,#10
00001028:1AFFFFF9           BNE l
0000102C:EAFFFFFF           B end
                        end:
00001030:E5825000           STR R5,[R2]
00001034:EF000011           SWI 0x11...
```

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4th Semester, Academic Year 2022-23

Date:

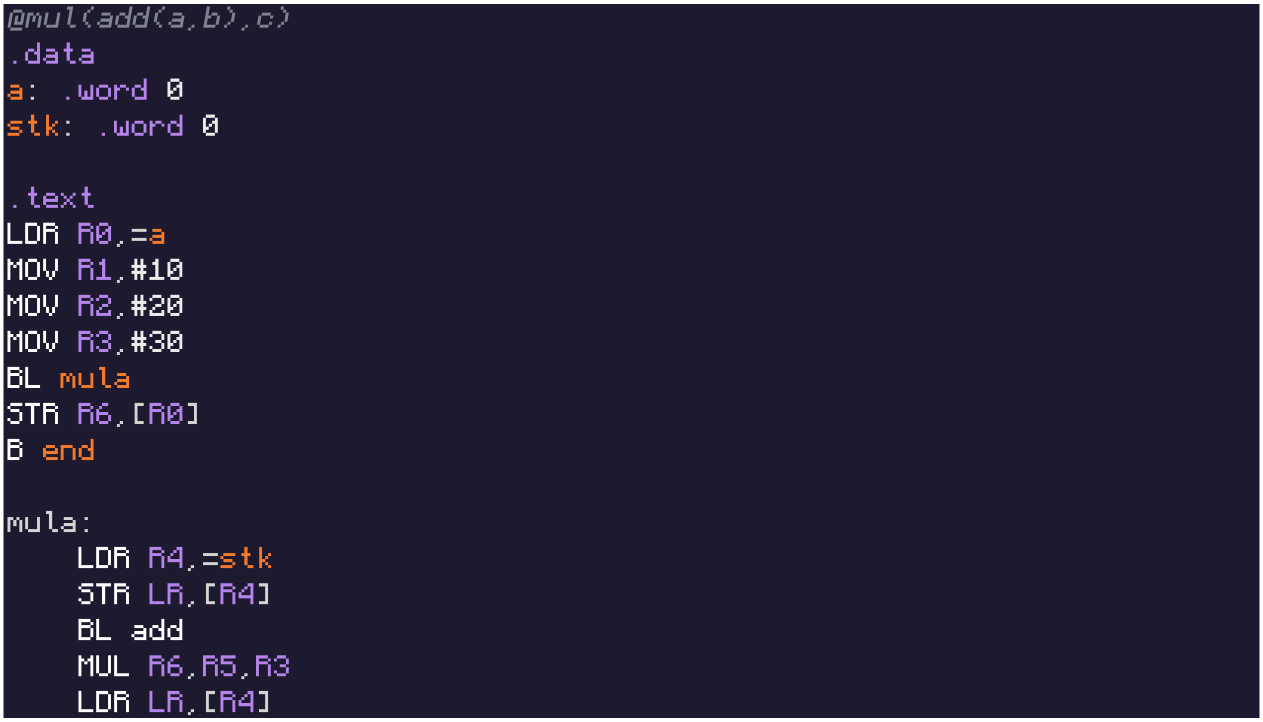
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____5__

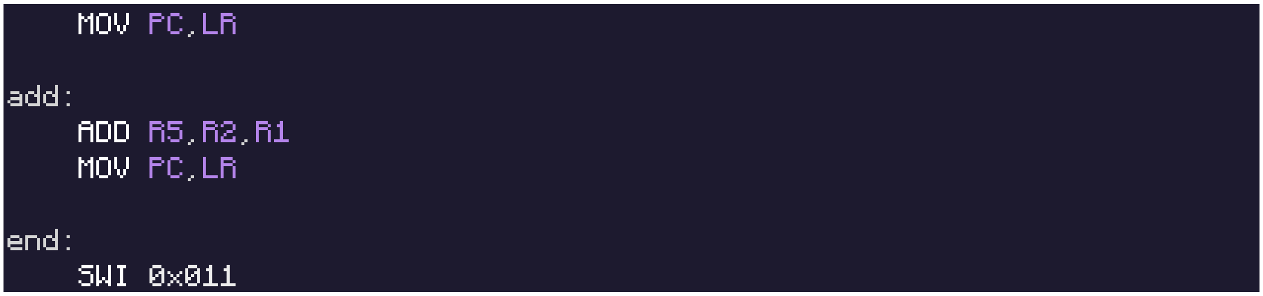
Title of the Program

Write an ALP to find mul (add(a,b),c)

I.ARM Assembly Code:

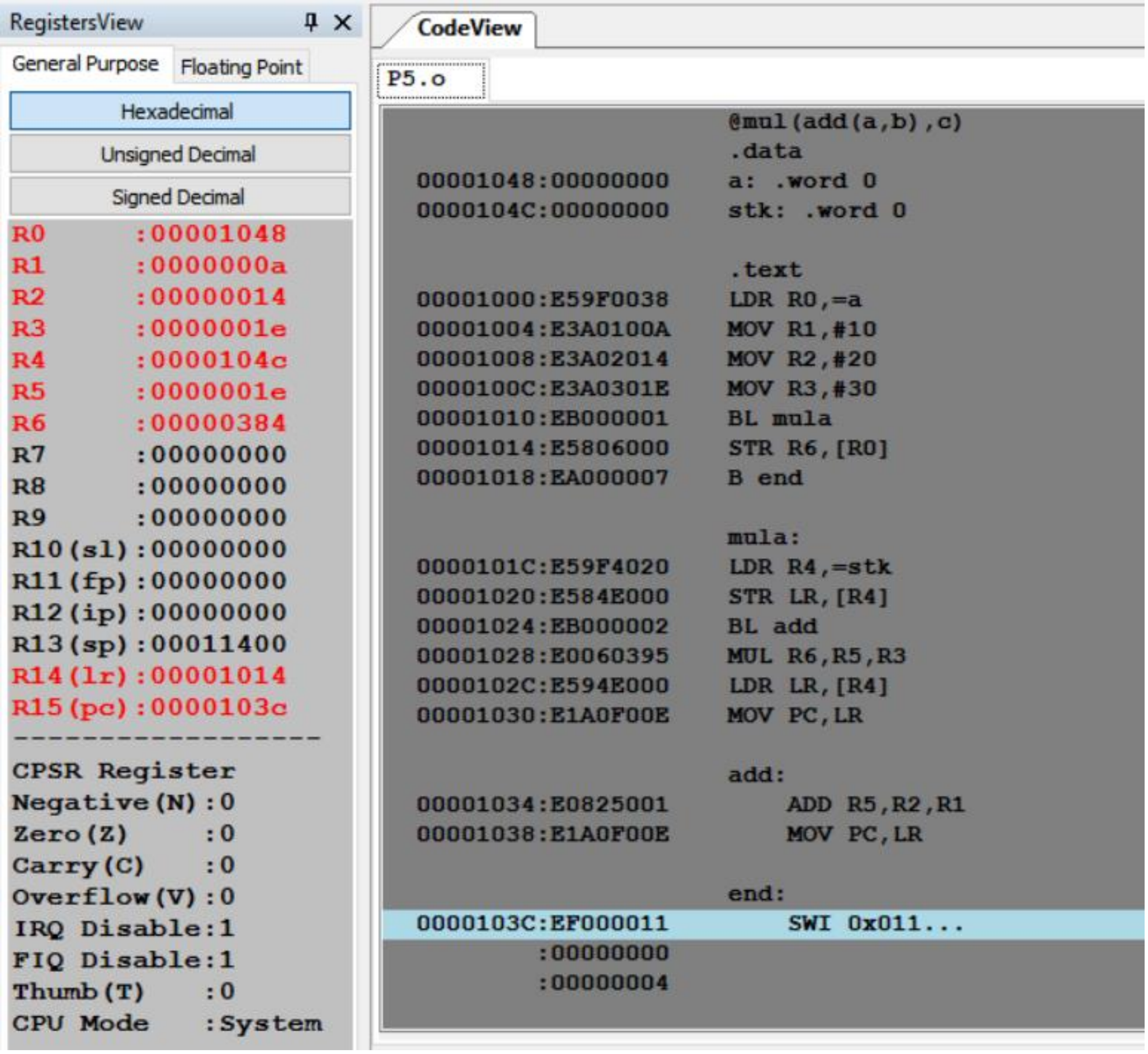


```
@mul(add(a,b),c)
.data
a: .word 0
stk: .word 0

.text
LDR R0,=a
MOV R1,#10
MOV R2,#20
MOV R3,#30
BL mula
STR R6,[R0]
B end

mula:
    LDR R4,=stk
    STR LR,[R4]
    BL add
    MUL R6,R5,R3
    LDR LR,[R4]
```



```
    MOV PC,LR

add:
    ADD R5,R2,R1
    MOV PC,LR

end:
    SWI 0x011
```

II. Output Screen Shot (One):



```
R0       :00001048
R1       :0000000a
R2       :00000014
R3       :0000001e
R4       :0000104c
R5       :0000001e
R6       :00000384
R7       :00000000
R8       :00000000
R9       :00000000
R10(sl) :00000000
R11(fp) :00000000
R12(ip) :00000000
R13(sp) :00011400
R14(lr) :00001014
R15(pc) :0000103c
------------------
CPSR Register
Negative(N):0
Zero(Z)     :0
Carry(C)    :0
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
```

```
                          @mul(add(a,b),c)
                          .data
00001048:00000000         a: .word 0
0000104C:00000000         stk: .word 0

                          .text
00001000:E59F0038         LDR R0,=a
00001004:E3A0100A         MOV R1,#10
00001008:E3A02014         MOV R2,#20
0000100C:E3A0301E         MOV R3,#30
00001010:EB000001         BL mula
00001014:E5806000         STR R6,[R0]
00001018:EA000007         B end

                          mula:
0000101C:E59F4020         LDR R4,=stk
00001020:E584E000         STR LR,[R4]
00001024:EB000002         BL add
00001028:E0060395         MUL R6,R5,R3
0000102C:E594E000         LDR LR,[R4]
00001030:E1A0F00E         MOV PC,LR

                          add:
00001034:E0825001             ADD R5,R2,R1
00001038:E1A0F00E             MOV PC,LR

                          end:
0000103C:EF000011             SWI 0x011...
         :00000000
         :00000004
```

Microprocessor and Computer Architecture

UE21CS251B

4th Semester, Academic Year 2022-23

Date:

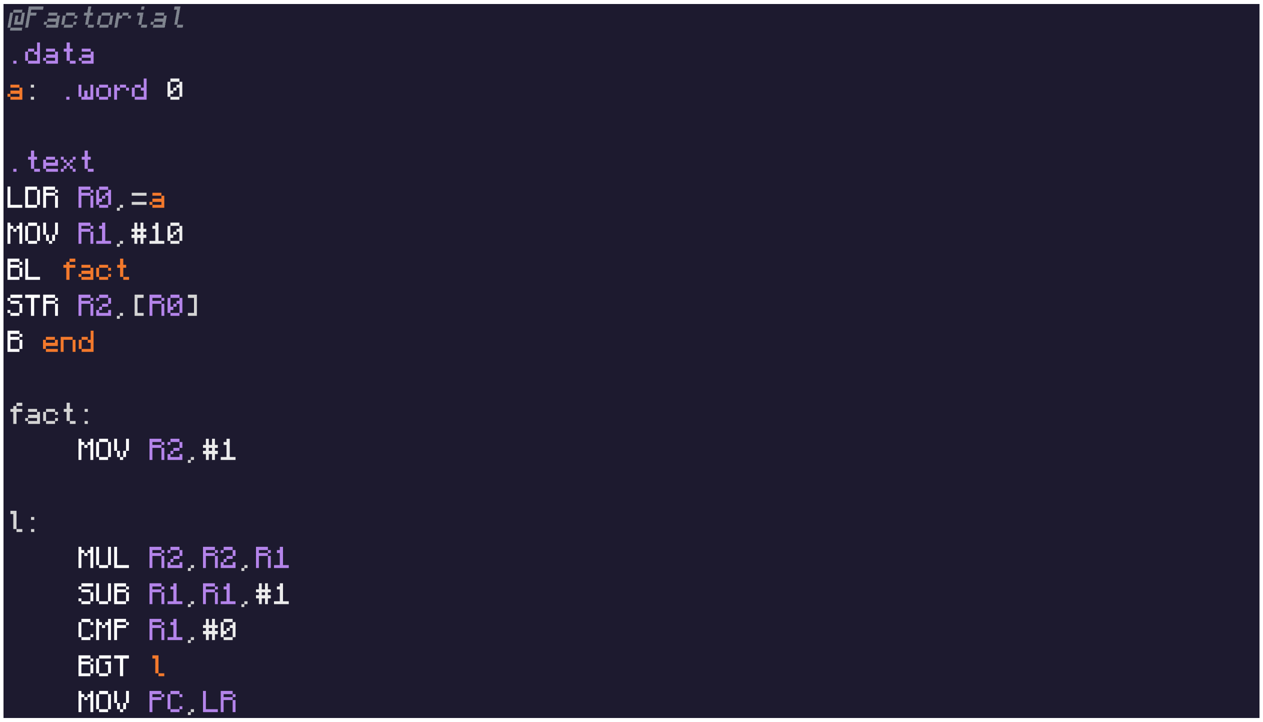
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____6__

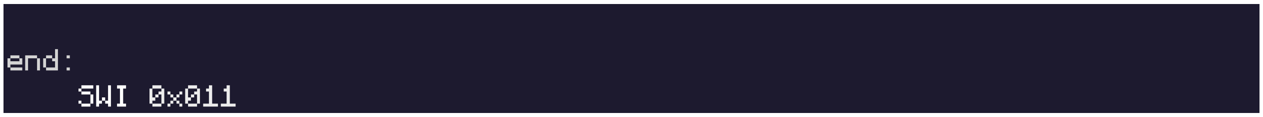
Title of the Program

Write an ALP to find factorial using subroutine

I.ARM Assembly Code:

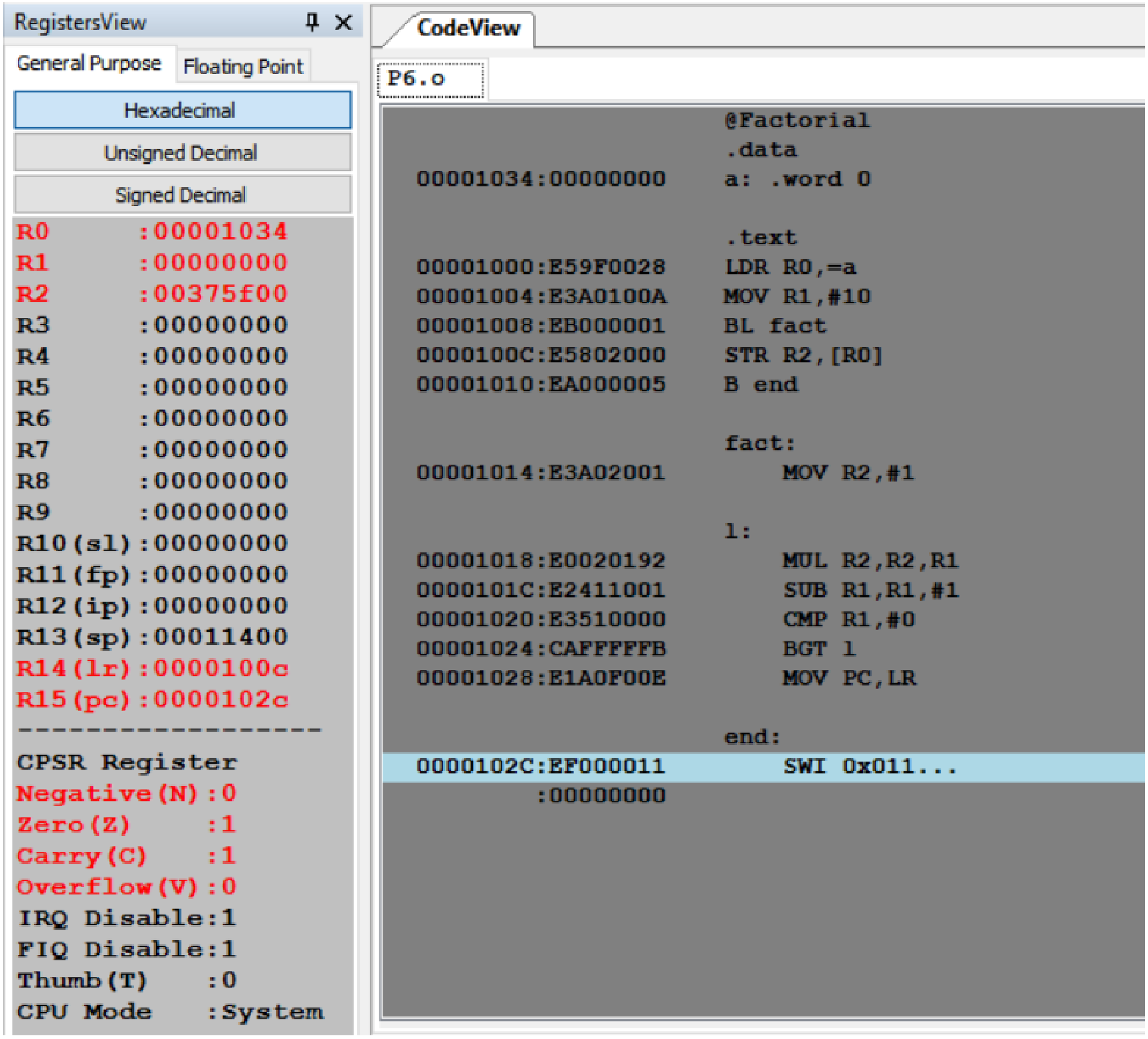


```
@Factorial
.data
a: .word 0

.text
LDR R0,=a
MOV R1,#10
BL fact
STR R2,[R0]
B end

fact:
    MOV R2,#1

l:
    MUL R2,R2,R1
    SUB R1,R1,#1
    CMP R1,#0
    BGT l
    MOV PC,LR
```



```
end:
    SWI 0x011
```

II. Output Screen Shot (One):



```
R0       :00001034
R1       :00000000
R2       :00375f00
R3       :00000000
R4       :00000000
R5       :00000000
R6       :00000000
R7       :00000000
R8       :00000000
R9       :00000000
R10(sl)  :00000000
R11(fp)  :00000000
R12(ip)  :00000000
R13(sp)  :00011400
R14(lr)  :0000100c
R15(pc)  :0000102c
------------------
CPSR Register
Negative(N) :0
Zero(Z)     :1
Carry(C)    :1
Overflow(V) :0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
```

```
                        @Factorial
                        .data
00001034:00000000       a: .word 0

                        .text
00001000:E59F0028       LDR R0,=a
00001004:E3A0100A       MOV R1,#10
00001008:EB000001       BL fact
0000100C:E5802000       STR R2,[R0]
00001010:EA000005       B end

                        fact:
00001014:E3A02001           MOV R2,#1

                        l:
00001018:E0020192           MUL R2,R2,R1
0000101C:E2411001           SUB R1,R1,#1
00001020:E3510000           CMP R1,#0
00001024:CAFFFFFB           BGT l
00001028:E1A0F00E           MOV PC,LR

                        end:
0000102C:EF000011           SWI 0x011...
         :00000000
```

Microprocessor and Computer Architecture

UE21CS251B

4th Semester, Academic Year 2022-23

Date:

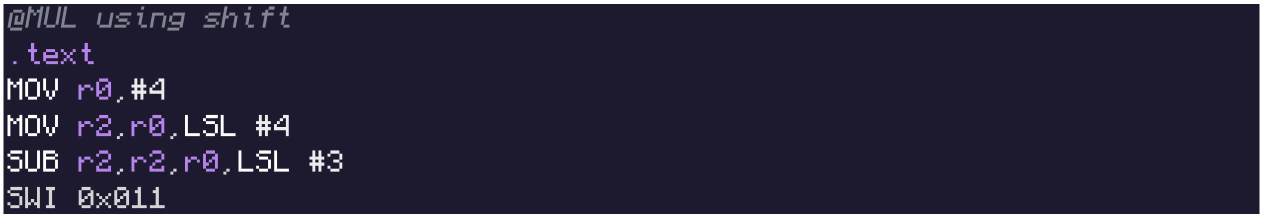
Name: Nikhil Girish	SRN: PES2UG21CS334	Section: F

Week#____3_______ Program Number: ____7__

Title of the Program

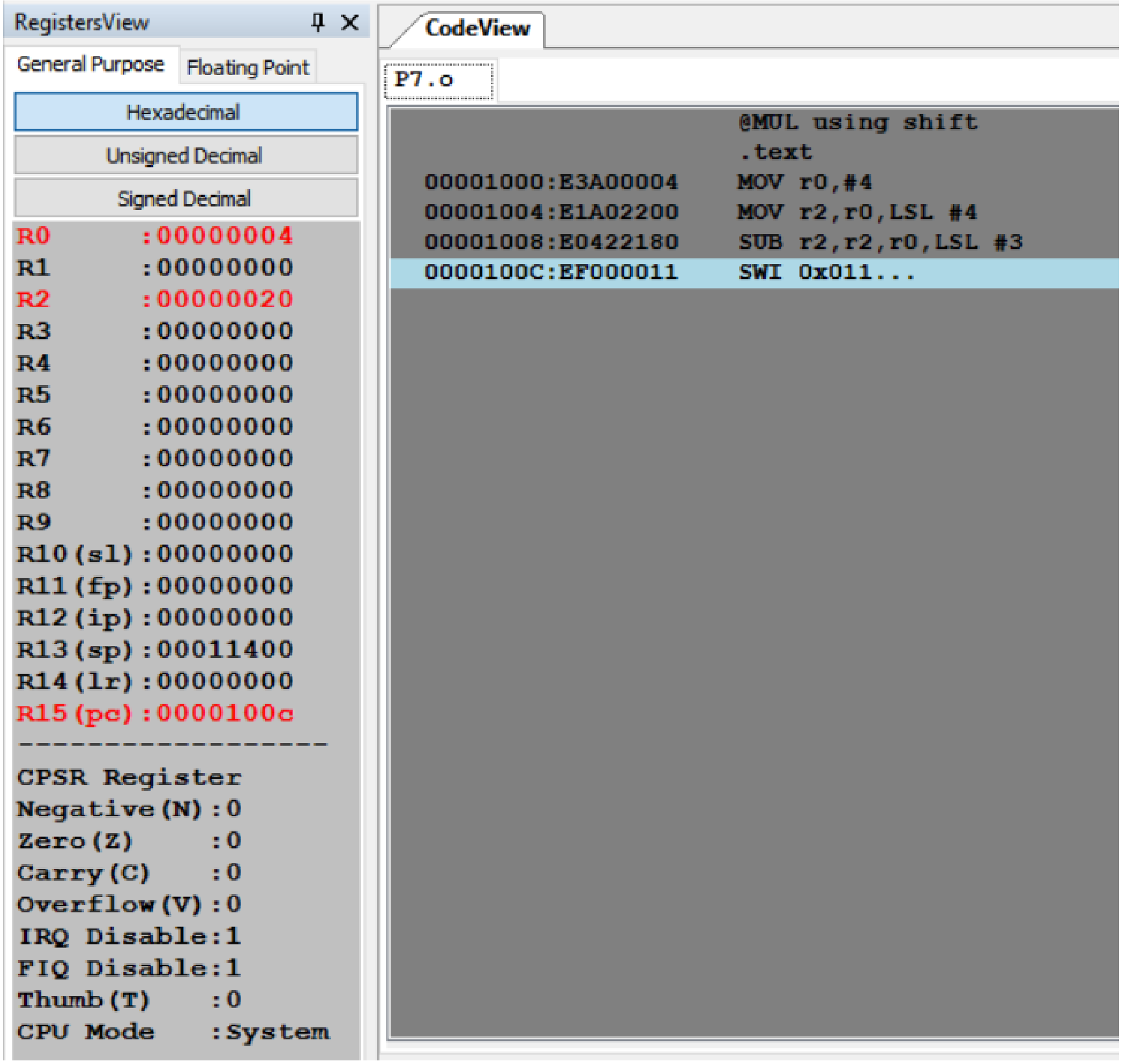
Write an ALP to perform multiplication using shift method (without using MUL)

I.ARM Assembly Code:



```
@MUL using shift
.text
MOV r0,#4
MOV r2,r0,LSL #4
SUB r2,r2,r0,LSL #3
SWI 0x011
```

II. Output Screen Shot (One):



```
R0        :00000004
R1        :00000000
R2        :00000020
R3        :00000000
R4        :00000000
R5        :00000000
R6        :00000000
R7        :00000000
R8        :00000000
R9        :00000000
R10(sl):00000000
R11(fp):00000000
R12(ip):00000000
R13(sp):00011400
R14(lr):00000000
R15(pc):0000100c
------------------
CPSR Register
Negative(N):0
Zero(Z)     :0
Carry(C)    :0
Overflow(V):0
IRQ Disable:1
FIQ Disable:1
Thumb(T)    :0
CPU Mode    :System
```

```
                        @MUL using shift
                        .text
00001000:E3A00004       MOV r0,#4
00001004:E1A02200       MOV r2,r0,LSL #4
00001008:E0422180       SUB r2,r2,r0,LSL #3
0000100C:EF000011       SWI 0x011...
```

Disclaimer:

- The programs and output submitted is duly written, verified and executed by me.
- I have not copied from any of my peers nor from the external resource such as internet.
- If found plagiarized, I will abide with the disciplinary action of the University.

Signature: Nikhil
Name: Nikhil Girish
SRN: PES2UG21CS334
Section: 4F
Date: 08/02/23